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# A Multidimensional Model of Project Leadership

Jennifer Shane

*Iowa State University*, [jsshane@iastate.edu](mailto:jsshane@iastate.edu)

Kelly Strong

*Iowa State University*, [kstrong@iastate.edu](mailto:kstrong@iastate.edu)

Douglas D. Gransberg

*Iowa State University*, [dgran@iastate.edu](mailto:dgran@iastate.edu)

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# A Multidimensional Model of Project Leadership

## **Abstract**

According to ASCE's Vision 2025 Report (ASCE, 2009), in order "To lead and execute complex projects that involve many and varied stakeholders and meaningful collaboration, civil engineers will have to command the multidisciplinary, multi-cultural, team-building, and leadership aspects of their work." In the traditional Iron Triangle of project management, the project leader's responsibility is to balance cost, schedule, and quality constraints to meet the owner's needs, which defines the scope of the project (Lewis, 2005). The Iron Triangle has lost much of its validity because it assumes only three dimensions of constraints, when in fact constraints can arise from multiple dimensions (PMI, 2008). Therefore, in addition to managing multi-disciplinary, multi-cultural teams, civil engineers will have to optimize constraint tradeoffs arising from multiple dimensions.

## **Keywords**

Chemical & Biological Engineering, Leadership

## **Disciplines**

Civil Engineering | Construction Engineering and Management | Other Civil and Environmental Engineering  
| Risk Analysis

## **Comments**

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## **A Multidimensional Model of Project Leadership**

Jennifer Shane, Ph.D., M.ASCE [jsshane@iastate.edu](mailto:jsshane@iastate.edu)

Kelly Strong, Ph.D., ASCE [kstrong@iastate.edu](mailto:kstrong@iastate.edu)

Doug Gransberg, P.E., Ph.D., ASCE [dgran@iastate.edu](mailto:dgran@iastate.edu)

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### **Introduction**

In the traditional Iron Triangle of project management, the project leader's responsibility is to balance cost, schedule, and quality constraints to meet the owner's needs, which defines the scope of the project (Lewis, 2005). The Iron Triangle has lost much of its validity because it assumes only three dimensions of constraints, when in fact constraints can arise from multiple dimensions (Project Management Institute, 2008). Therefore, in addition to managing multi-disciplinary, multi-cultural teams, civil engineers will have to optimize constraint tradeoffs arising from multiple dimensions.

The manuscript describes a multi-dimensional construct for project leadership involving the use of partnerships to manage tradeoffs among dynamic, inter-connected project constraints arising both within and outside the project team, across the entire project life cycle, and all along the value chain. In addition to the typical cost/schedule/quality deliberations, the nature and source of financing, global markets for material, labor, and services, political influence of external stakeholders, and risk factors beyond cost and schedule must all be considered in making project leadership decisions.

Project Managers and their stakeholders clearly need to add partnering as a risk mitigation tool alongside CPM schedules, Quality Assurance/ Quality Control (QA/QC) plans, cost control systems, and scope control protocols. According to ASCE's Vision 2025 Report (ASCE, 2009), in order "To lead and execute complex projects that involve many and varied stakeholders and meaningful collaboration, civil engineers will have to command the multidisciplinary, multi-cultural, team-building, and leadership aspects of their work. Historically, one of the most common forms of developing collaboration among varied stakeholders is through the use of partnering.

The term “partnering” has taken on several definitions over time. The earliest forms of partnering describe the efforts by the project owner to develop a work-friendly relationship with its low-bid construction contractors. Research in that area found that the investment of time and a small amount of resources paid dividends in reducing cost and schedule growth as well as minimizing post-construction litigation (Gransberg et al. 1998). Recently, partnering has changed to represent something deeper and more intense than a mere workshop and nonbinding project charter of the 90’s. Partnering has become a business practice that denotes integrating the needs and preferences of project stakeholders outside the traditional owner-designer-contractor contractual relationship around which traditional project management revolves. Public transportation agencies in Australia and New Zealand use a project delivery methods called “Alliancing” where the owner, designer, and builder agree to a contract that specifically excludes litigation as a dispute resolution process and contains an innovative distribution of costs and saving to all three parties (Scheepbouwer 2010). The US has not yet reached this level of commitment; however, US agencies have defined a need for non-contractual mechanisms that bring substantive input to the project team from third-party stakeholders. Such information sharing is essential to the successful delivery of complex transportation infrastructure (Shane, Strong and Gransberg 2010) . Therefore, this paper will explore several case studies where this broader definition of partnering has been successfully enacted.

## **Partnering as Effective Project Management**

### *Partnering with utilities- New Mississippi River Bridge in St. Louis:*

The New Mississippi River Bridge project in St. Louis, Missouri and East St. Louis, Illinois consists of building a new, four lane, long span, cable-stayed bridge across the Mississippi River one mile north of the existing Martin Luther King Bridge. In addition, the project includes a new North I-70 interchange roadway connection between the existing I-70 and the new bridge, with further connections to the local St. Louis street system at Cass Avenue. On the Illinois side, the project includes a new I-70 connection roadway connection between the existing I-55/64/70 Tri-Level Interchange and the main span and significant improvements at the I-55/64/70 Tri-Level Interchange in East St. Louis which will connect to the new I-70 Connection leading to the main span.

The risk analysis and assessment was a very thorough, formal process and was started early in the planning and design phase. Use of the formal risk analysis process helped the team identify risks at an early stage, when mitigation steps could still be enacted. A good example is the identification of potential schedule delays involving coordination of design with the railroads. The team devoted \$50,000 to \$200,000 from the project contingency funds to help railroads and other utilities hire additional staff to complete designs and project reviews necessary to maintain the project schedule. This type of partnering arrangement where non-contractual partners are incentivized to meet project deadlines is an excellent example of how early, mutually beneficial engagement of partners can improve risk management practices.

### *Partnering with the public: James River Bridge, Richmond, VA:*

The I-95 James River Bridge project in Richmond, Virginia, consists of the restoration of the 1.2 km James River Bridge on I-95 through the central business district of Richmond, Virginia. The bridge is 1.2

km long, six lanes wide, and a maximum of 29.3 m high. When originally built in 1958, traffic capacity was approximately 40,000 vehicles per day. When rebuilt in 2002, actual traffic volume was 110,000 vehicles per day. The contractor proposed to use preconstructed composite units (PCUs) which consisted of an 22 cm concrete deck over steel girders fabricated nearby. Crews cut the old bridge spans into segments, removed them, and prepared the resulting gaps for the new composite unit. Lastly, they set the new prefabricated unit in place overnight. The project included supplemental improvements to widen Route 1, enhance signalization and install a high mast lighting system.

Partnering with the public, including various state and city organizations, was very important to Virginia Department of Transportation (VDOT) in the planning stage. VDOT mounted a full-scale public relations and information campaign almost as soon as the project concept was approved. VDOT made a concentrated effort to ensure that the residents and business leaders of Richmond were involved in the process to bring the most suitable solution to restoring structural integrity to the bridges on I-95 that runs through the heart of the city. The planning process from inception to completion took a total of three years. The primary goal was to minimize impact to the traveling public as well as the community during construction. The centerpiece of the public involvement plan was to modify traveler behavior by influencing them to “self-detour” and avoid the area once construction had commenced, including partnering with major freight haulers two years before construction started in order to encourage them to begin planning to reroute their trucks during the construction period. The second part of the “self-detour” plan was for commuter traffic. This too was commenced at the outset of the planning phase (Kozel, 2003). For example, the Summer 2001 edition of the I-95 Bridge Restoration Newsletter (VDOT, 2001) contains an article warning commuters: “If you use this stretch on I-95 to get home in the evening, you should look for an alternate route once construction begins in 2003.” Variable message boards were deployed throughout the corridor to announce the upcoming lane closures a year in advance.

A Community Advisory Group had weekly meetings on the progress of the project, and the partnering relationships made during the planning phase were maintained during design and construction. VDOT and the contractor were open to making minor adjustments in the construction schedule to accommodate downtown businesses with specific needs, such as changing the full-closure timing to permit a large delivery that had to be made during active construction. As a result of the public involvement program’s success, VDOT was presented the American Association of State Highway and Transportation Officials (AASHTO) Excel Award for Excellence in Public Relations.

#### *Partnering with neighborhoods-Ohio River Bridges Project, Louisville/Southern Indiana:*

The Ohio River Bridges project in Louisville, Kentucky/ Southern Indiana is a complex project currently entering the final stages of the design phase. It consists of two long span river crossings across the Ohio River (one in downtown Louisville, one on the east side of the metro), a new downtown interchange in Louisville, a new approach and a 6.76 km highway on the Indiana side, a new East End approach on the Kentucky side, including a 610 m tunnel, and reconfiguration of existing interchanges to improve congestion, mobility, and safety.

Many issues on this project were related to historic preservation, with plans submitted to each city, village, and neighborhood group. The final project will result in more public land use by converting old industrial areas to the new interchange, and reverting the existing interchange land to public parks.

The project prompted some long-term land use planning by local agencies. Extensive analysis during the development of the Environmental Impact Statement (EIS) helped with corridor-level planning decisions.

The project team made a decision to use a tunnel for historic preservation of a Frederick Law Olmsted country estate design and to mitigate Section 4F (historical) issues in that area of the project. Alternative solutions would have required relocation of the corridor alignment.

In general, the project has a positive rating in the community, with 76% of the public at large supporting the project. There is widespread understanding of the need for the project. Historic Preservation Teams give credibility to project and help overcome some of the political opposition. The State Historic Preservation Office (SHIPO) and local groups meet with project team every month. The use of a public relations and communication consultant has been valuable in coordinating information and providing a central point of contact for public and the media. Another aspect of partnering with local neighborhood groups was the implementation of a Smart Growth conference to facilitate a dialogue among historic districts, local government agencies, and the project team.

*Partnering with other government agencies-Doyle Drive, San Francisco:*

The Doyle Drive project, (also known as the Presidio Parkway), is a unique project that is the south access to the Golden Gate Bridge. The Doyle Drive corridor, 2.4 km in length, was originally built in 1936 to usher traffic through the Presidio military base to connect San Francisco and the Golden Gate Bridge. Doyle Drive is in the Presidio and the Golden Gate National recreation Area and is located in a high seismic hazard zone. There are a number of historic buildings and other considerations in the area. The Presidio was listed as a National Historic Landmark District in 1962 and in 1966 was listed on the National Register of Historic Places. The project also passes close to a National Military Cemetery. The project requires a high degree of partnership with other government agencies, including:

- California Department of Transportation,
- San Francisco County Transportation Authority,
- Presidio Trust,
- National Park Service,
- California Department of Veterans Affairs,
- Golden Gate Bridge Highway Transportation District,
- Metropolitan Transportation Commission, and
- Federal Highway Administration.

This project was originally intended to be let as a single project. However, the estimated cost of the project was over a billion dollars. The 2007 funding plan of for this project included federal grant, through the Urban Partnership Program, which required congestion-based tolling. This toll would increase and decrease with the amount of traffic on the Golden Gate Bridge and Doyle Drive. This plan was not well received and was eventually dropped (Cabanatuan 2008, Stonehill 2007). "The threats of congestion pricing really forced us to collaborate in ways we never thought," was the statement from the Mayor of San Francisco after years of "battles over funding." (Kuruvila 2009) The Metropolitan Transportation Commission proposed their funding of \$80 million of the project if it was matched (Cabantuan 2008). This match was met with \$75 million from the Golden Gate Bridge Highway and Transportation District, \$4 million from Marin County's Transportation Program and \$1 million from the Transportation Program of Sonoma County (Golden Gate Bridge Highway and Transportation District et al, 2008). The final funding from the project came from the 2009 American Recovery and Reinvestment Act stimulus package. This additional funding made it so the project could start sooner, saving the entire project \$115 million. Additionally, the project was "re-planned to accommodate an accelerated

schedule to receive this funding” and helped prompt the division of work into eight separate contracts (Federal Highway Administration et al. 2009)

*Partnering with financiers- Inter-County Connector, Washington DC/Maryland:*

The Intercounty Connector (ICC) has been planned and studied for over 50 years, and its design was developed with extensive involvement by the Montgomery County and Prince George's County communities in Maryland. The new east-west highway will cover approximately 30 km, and will include the construction of numerous new highway interchanges and bridges. The ICC will be a state-of-the-art, toll operated, multi-modal roadway with limited points of access.

The ICC project will provide a myriad of benefits to the Washington, DC and Baltimore metropolitan areas. It is intended to increase community mobility and safety; facilitate the movement between economic centers of people and goods; provide cost-effective transportation infrastructure to serve existing and future development which reflects local land use objectives; help restore the natural, human, and cultural environments changed by past development impacts; and enhance homeland security.

The total anticipated cost is approximately \$2.566 billion. The project is using multiple funding sources and will be part of Maryland’s tolling network upon completion. Grant Anticipated Revenue Vehicles (GARVEE) bonds, Maryland Department of Transportation Pay-as-you-go (P.A.Y.G.) program, special federal funds, Maryland Transportation Authority bonds, Maryland general fund transfers, and a TIFIA loan are all sources of funding that are being used for this project. A breakdown of the financing is as follows:

- \$750 million in GARVEE bonds
- \$715.6 million in Authority toll revenue bonds and cash (MdTA)
- \$516 million in TIFIA loans
- \$264.9 million in state general
- \$180 million in state transportation trust funds
- \$19.3 million in special federal funds
- \$16.9 million in additional. funds from GARVEE sale
- TOTAL COMMITTED \$2.4627 billion
- Unidentified final funding for Contract D (outside the 6 year program) is \$103.2 million.

The ability of project managers to meet the requirements of different financing entities will become increasingly important in the future. The nature of funding will impact schedule, budget and design decisions in all phases of the project life cycle. In addition, project managers will need more “administrative” skills to properly manage and audit expenses and revenues attributable to different funding sources.

*Partnering with industry- Northern Gateway Alliance, New Zealand:*

The Northern Gateway Toll Road) was the first toll road in New Zealand (NZ) to be fully electronic and the construction project was one of New Zealand’s largest, most challenging and most complex to date. It extends the four lane Northern Motorway 7.5km further north from Orewa to Puhoi through historically rich and diverse landscapes, steep topography and local streams and provides an alternative to the steep two-lane road winding coastal route through Orewa and Waiwera. The \$360 million (US\$)

extension of State Highway One was constructed to provide a straight and safe drive between Auckland and Northland. The project was delivered by the Northern Gateway Alliance comprised of Transit New Zealand, Fulton Hogan, Leighton Contractors, URS New Zealand, Tonkin & Taylor and Boffa Miskell. The road which opened in January 2009 has become a visual showcase of environmental and engineering excellence.

Project investigation started in the early 1990's, was put on hold, and started again with granting of consents (permits) and designations at the end of 2003. The remainder of 2003 and 2004 were used for procurement. Funding for the project was not yet in place at the start of the project and the use of existing roads as temporary bypasses for traffic were challenged in court. Extension of the use of these alternative roads was approved on a year-by-year basis, depending on proof of construction of the Northern Gateway. As the Highway Authority did not have the required funds, a business case was made for the Treasury, which finally lent the remaining funds to the Highway Authority in exchange for tolling rights for 35 years during the design phase. Risk for this income was transferred to Treasury.

Technically challenging aspects of the project included tunneling, which had not been done by the agency in decades; a largely unknown geotechnical situation and building on environmentally protected land. Construction of the road through protected area was challenged and solutions were used to minimize the environmental impact, like the twin tunnel.

All the uncertainties in the project including the necessitated early start of construction made design-bid-build delivery impossible; essential risk transfer was deemed to make design-build too expensive. Additionally, although a public-private-partnership would have been possible from a business case point of view, there was considerable political unease with this method of delivery. Alliancing however gave the option to start construction after a very preliminary design scope was established. The alliance partners were aware of the fact that funding approval was pending, and the risk that the project could be halted was shared. "Pure" alliancing was used as opposed to competitive alliancing, which is more common in Australia. Pure alliancing versus competitive alliancing differs in procurement. In pure alliancing, the owner shortlists to preferred supplier on non-price attributes, which then starts the design and produces a target outturn cost (TOC). In a competitive alliance there are two competing teams producing a TOC, and then the evaluation is done, incorporating a cost component. During design the suppliers are paid a fee for intellectual property. After award both forms of alliancing become 'true' alliances with a cost share model.

The Northern Gateway Alliance was formed by Transit New Zealand in 2004 to design, manage, and construct Northern Gateway Toll Road. Eight organizations make up the alliance, each member playing a critical role in ensuring an innovative, efficient and cost-effective project. The alliance partners are owner-participant NZ Transport Agency (formerly Transit), Fulton Hogan, Leighton Contractors, URS New Zealand, Tonkin and Taylor, Boffa Miskell VSL and United Group Ltd. Within the alliance there are multitudes of specializations. NZ Transport Agency develops, manages and maintains the country's state highways. Fulton Hogan is a dynamic, diversified contracting company active in New Zealand, Australia and the Pacific Basin. Leighton Contractors is a publicly listed Australian contracting company delivering projects to governments, major corporations and other clients across Australia. URS New Zealand is a professional services company providing engineering and environmental expertise across New Zealand, Asia Pacific and in other parts of the world. Tonkin & Taylor is a New Zealand-owned, international environmental and engineering consultancy, Boffa Miskell is a leading New Zealand environmental planning and design consultancy providing integrated solutions for public and private sector clients and sub-Alliance member VSL brings to the Alliance specialist international knowledge of large span bridge

engineering and construction methodology. Sub-alliance partner, United Group Limited (UGL) also brings specialist international knowledge to the Northern Gateway Toll Road. UGL, who is in charge of completing the project's tunnels mechanical and electrical services, is a leading Australian engineering and services group, operating throughout Australia, New Zealand, Asia, US and the UK.

## Summary and Conclusion

The preliminary findings from the case studies conducted as part of the SHRP 2- R10 research project on strategies for managing complex projects indicate that project management must move beyond the historical focus on cost, schedule, and technical control. Project leaders of the modern era must understand the impact that external stakeholders have on the ability to bring projects in on time, on schedule, and on quality. One of the most effective techniques for managing the complex interactions between project issues (cost/schedule/quality) and external stakeholder issues is through partnering. Specific, exemplary results from select cases have been presented above. A full discussion of how partnering can be used to improve management of complex projects is beyond the scope of this paper but will be made available in the near future as part of the SHRP 2 implementation program. A comprehensive review of the successful project management strategies for the major projects included in the SHRP 2- R10 project (shown in Appendix A) indicate that project leaders use a broad approach to partnering in order to:

- \* Improve Information planning and communication
- \* Improve social sensitivity and build public support
- \* Improve feasibility and facilitate innovative financing
- \* Improve sustainability and project performance

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## Appendix A

Capital Beltway, Virginia  
Detroit River International Crossing, Michigan  
Doyle Drive, California  
Green Street, Saskatchewan CANADA  
Heathrow T5, London ENGLAND  
Hudson-Bergen Light Rail, New Jersey  
I-40 Crosstown, Oklahoma  
I-95 New Haven Harbor Crossing, Connecticut  
I-595 Corridor, Florida  
Intercounty Connector, Maryland  
James River Bridge/I-95 Richmond, Virginia  
Lewis and Clark Bridge, Washington/Oregon  
Louisville Southern Indiana Ohio Bridge Crossing Kentucky/Indiana  
New Mississippi River Bridge, Illinois/Missouri  
North Carolina Tollway, North Carolina  
Northern Gateway Toll Road, NEW ZEALAND  
T-Rex, Colorado  
TX SH 161, Texas

**Brief bio: Jennifer Shane, Ph.D., M.ASCE**

Jennifer S. Shane is an Assistant Professor in Civil, Construction, and Environmental Engineering at Iowa State University. Dr. Shane received her B.S. from the Colorado School of Mines and both her M.S. and Ph.D. from the University of Colorado at Boulder, all in Civil Engineering. Dr. Shane worked for the Kansas Department of Transportation between her undergraduate and graduate degrees. Jennifer's research interests include project management of infrastructure projects.

**Brief bio: Kelly Strong, Ph.D., ASCE**

Kelly Strong is an Associate Professor in Civil, Construction, and Environmental Engineering at Iowa State University. Dr. Strong received his B.S. in Civil Engineering from the Iowa State University and his Ph.D. from the University of Colorado at Boulder. Dr. Strong worked as a project manager for a large, vertically integrated design builder for eight years prior to entering academia. Dr. Strong's research interests include project management of infrastructure projects and risk management and mitigation.

**Brief bio: Doug Gransberg, P.E., Ph.D., ASCE**

Douglas D. Gransberg is the Donald and Sharon Greenwood Chair and Professor of Construction Engineering at Iowa State University. He received both his B.S. and M.S. degrees in Civil Engineering from Oregon State University and his Ph.D. in Civil Engineering from the University of Colorado at Boulder. He is a registered Professional Engineer in Oklahoma, Texas and Oregon, a Certified Cost Engineer, a Designated Design-Build Professional and a Chartered Surveyor by the Royal Institute of Chartered Surveyors in the UK. Before moving to academia in 1994, he spent over 20 years in the U.S. Army Corps of Engineers working both in the US and overseas.